

CRUISE REPORT¹

VESSEL: *Hi`ialakai*, Cruise HI-06-05

CRUISE PERIOD: Part 1: 19-24 April 2006
Part 2: 28 April-11 May 2006

AREA OF OPERATION: Part 1: South shore Oahu, Penguin Bank
Part 2: Penguin Bank, north shore Molokai, Lanai, northwest coast Big Island

TYPE OF OPERATION: Personnel from the Coral Reef Ecosystem Division (CRED) of NOAA's Pacific Islands Fisheries Science Center (PIFSC), the National Marine Sanctuaries Program (NMSP), the Office of Coast Survey (OCS), and the United States Fish and Wildlife Service (USFWS) conducted multibeam calibrations at Barber's Point and near the mouth of Honolulu Harbor and multibeam mapping on Penguin Bank between Molokai and Oahu, on the north shore of Molokai, around Lanai, and on the northwest coast of the Big Island of Hawai'i.

ITINERARY:

PART 1 – HI-06-05:

19 April (JD 109) Start of cruise. Embarked Susan Vogt (Co-Chief Scientist, NMSP), Scott Ferguson (CRED), John Rooney (CRED), Jeremy Jones (CRED), Emily Lundblad (CRED), Jonathan Weiss (CRED), Kyle Hogrefe (CRED), Jamie Smith (UH/HMRG), Ron Salz (USFWS), Megan Palmer (NOAA Office of Coast Survey), and Paul Turner (NOAA OCS). Departed Honolulu at 0900; fire and abandon ship drills were held during transit to Barbers Point. Conducted multibeam calibrations near Barbers Point.

20 April (JD 110) Transited to outfall calibration site near Honolulu Harbor. Conducted multibeam calibrations. Launched HI1 at 1300 (L) to disembark Scott

¹ PIFSC Cruise Report CR-06-018
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Ferguson, First Assistant Engineer and NMAO Safety Officer. Picked up Joyce Miller (Co-Chief Scientist, CRED) at Snug Harbor and returned to ship. Transited to Penguin Bank, performed conductivity-temperature-depth (CTD), and began multibeam survey of Penguin Bank.

- 21 April (JD 111) Conducted multibeam survey and CTDs on Penguin Bank. Ron Salz (USFWS) pinched two fingers on his right hand in the bathroom door and the Chief Steward (Acting Medical Officer) examined and bandaged them. Appropriate forms were submitted to USFWS management to report this accident.
- 22 April (JD 112) Conducted multibeam survey and CTDs on Penguin Bank.
- 23 April (JD 113) Conducted multibeam survey and CTDs on Penguin Bank and ran lines to determine source of offset between 2005 and 2006 multibeam data.
- 24 April (JD 114) Conducted multibeam survey and CTDs on Penguin Bank until noon (local time). Transited to outfall site near Honolulu Harbor and launched R/V *AHI* to run calibrations. (Note: *AHI*'s engine failed during these calibrations and she was towed in by the *Hi'ialakai* rescue boat.)

At 1530, tied up at Aloha Tower for transition to NMSP Education and Outreach (E&O) cruise. Disembarked Joyce Miller, Susan Vogt, John Rooney, Jonathan Weiss, Emily Lundblad, Kyle Hogrefe, Jamie Smith, Megan Palmer, and Paul Turner. (Jeremey Jones remained onboard to participate in the E&O cruise).

Education and Outreach Cruise Period

- 25-27 April Remained ashore while Education and Outreach cruise was conducted by NMSP. Susan Vogt (NMSP) and Jeremey Jones (CRED) participated in E&O operations to demonstrate multibeam mapping to students from Oahu and Kauai.

R/V *AHI* problem proved to be a bad fuel pump, which was repaired on April 25. Calibration surveys were done on R/V *AHI* on April 26.

PART 2: HI-06-05

- 28 April (JD 118) Continuation of cruise. Embarked Susan Vogt (Co-Chief Scientist, NMSP), Joyce Miller (Co-Chief scientist, CRED), John Rooney (CRED), Jeremey Jones (CRED), Emily Lundblad (CRED), Jonathan Weiss (CRED), Kyle Hogrefe (CRED), Frances Lichowski (CRED), Jamie Smith (UH/HMRG), Megan Palmer (NOAA OCS), and Paul Turner

- (NOAA OCS) via small boat at 0830. Departed Honolulu, and fire and abandon ship drills were held during transit to Penguin Bank.
- 29 April (JD 119) Conducted multibeam operations and CTDs on Penguin Bank. Continued collaboration with OCS personnel to document and calibrate multibeam system setup and operation. It was determined that offsets between 2005 and 2006 data were caused by tides that were incorrectly applied to 2005 data.
- 30 April (JD 120) Conducted multibeam survey and CTDs on Penguin Bank. Ran three calibration lines for settlement and squat. Deployed R/V *AHI* to collect multibeam data on Penguin Bank.
- 1 May (JD 121) Conducted multibeam survey and CTDs on Penguin Bank. Ran one additional calibration line for settlement and squat. Deployed R/V *AHI* to collect multibeam data on Penguin Bank.
- 2 May (JD 122) Transited to east end of Molokai to deploy R/V *AHI* for shallow water survey at Halawa Bay and Kalaupapa. Conducted multibeam gap fills along north shore of Molokai. Two recreational snorkel/dive trips were done during the day. Retrieved *AHI* near Kalaupapa and transited to fill gaps along north and west shores of Molokai. Returned to Penguin Bank.
- 3 May (JD 123) Transited to south end of Lanai to deploy *AHI* for shallow multibeam survey around island. Conducted ship multibeam survey and CTD cast along north shore of Molokai. Retrieved *AHI* on south shore of Lanai and returned to Penguin Bank for night survey.
- 4 May (JD 124) Conducted multibeam survey and CTDs on Penguin Bank.
- 5 May (JD 125) Conducted multibeam survey on Penguin Bank. Transited to Honolulu to disembark Megan Palmer (OCS) at 1300 via small boat (launch *HII*). Conducted gap fills to complete survey of Penguin Bank. Departed Penguin Bank at 1900 for transit to northwest coast of Big Island. Fire and abandon ship drills were held during transit.
- 6 May (JD 126) Began survey of Hawaiian Islands Humpback Whale National Marine Sanctuary and Essential Fish Habitat (100-500 m) on northwest coast of Big Island. Conducted CTDs to support multibeam operations. Launched R/V *AHI*.
- 7 May (JD 127) Conducted multibeam survey and CTDs on northwest coast of Big Island. Launched R/V *AHI*. Launched *HII* to pick up 1st Asst. Engineer at Honokohau Harbor near Kailua-Kona. Problems were encountered with survey system on R/V *AHI*; troubleshoot survey system in evening to determine source of problem.

- 8 May (JD 128) Conducted multibeam survey and CTDs on northwest coast of Big Island. At 1000 the bridge reported that the *Hi'ialakai's* starboard engine had problems and that the engine needed to be secured. Survey was continued at reduced speed using port engine only until ~1500 when a repair was done and both engines were brought back on-line.
- Troubleshooting continued on *AHI* survey system in the morning and *AHI* was launched at 1330. Some survey was conducted, but problems with *AHI* computer reoccurred.
- 9 May Conducted multibeam survey and CTDs on northwest coast of Big Island. At 0600 tests were conducted on starboard engine to determine status of repair, which appeared to be successful. Survey was continued at normal operating speeds of up to 7.5 knots.
- 10 May Conducted multibeam survey and CTDs on northwest coast of Big Island. A recreational snorkel and beach visit were done using the *HII* launch. Departed Big Island and filled gaps in deep water off northwest coast; transited to Penguin Bank.
- 11 May Arrived Penguin Bank at 0730, conducted CTDs, and did multibeam gap fills. Stopped survey and transited to Oahu, arriving at sea buoy at 1530.

CRUISE STATISTICS

TABLE 1: CRUISE STATISTICS FOR HI-06-05

	Oahu	Penguin Bank	Molokai	Lanai	Northwest Coast Big Island	Totals
CTDs (ship & launch)	4	29	1	1	15	50
Multibeam mapping (sq. km)	n/a	584.68	17.42	28.01	748.71	1378.82
Calibration lines	39	6				45
R/V <i>AHI</i> deployments		2	1	1	5	9

MISSIONS AND RESULTS:

1. Mapping of Penguin Bank using ship-based and launch-based multibeam echosounders and underwater towed cameras: Mission completed. (See Appendix A; Figures A-1, A-2, and A-3)
2. Conducted shipboard and launch-based CTDs to support multibeam mapping requirements as needed.
3. Mapping of gaps in shallow areas around north shore of Molokai at Halawa Bay and Kalaupapa Peninsula using launch-based multibeam sonar. Fill in gaps between existing multibeam coverage and aerial survey data in these areas. This mission was 95% completed with one small gap remaining near Kaulapapa. See Appendix A, Figure A-4.
4. Conducted one day of mapping using ship and launch multibeam sonars around Lanai. Approximately 15% of mapping needed near Lanai was completed. The remaining 85% is almost entirely work that must be done by the R/V *AHI* (or other shallow mapping vessels) due to depth and distance limitations for ship-based mapping. See Appendix A, Figure A-4.
5. Conducted mapping on northwest coast of Big Island of Hawaii to support NMSP requirements for benthic habitat mapping in waters up to 183 m (100 fm) as well as NOAA PIFSC and Hawaii Department of Land and Natural Resources, Department of Aquatic Resources (DLNR/DAR) requirements for definition of Essential Fish Habitat in unmapped areas in water depths of 50-500 m . Five and a half days of ship mapping and 5 days of launch mapping were conducted on the northwest coast of the Big Island and 748.71 km² of seafloor was covered. (See Appendix A, Figure A-5). The remaining portion of this area on the northwest side of the island is almost entirely work that must be done by R/V *AHI* (or other shallow mapping vessels) due to depth and distance limitations for ship-based mapping. This mapping around the Big Island was not planned in the original cruise instructions, but exceptionally calm conditions permitted the completion of Penguin Bank survey in less time than expected, allowing the mapping team to conduct mapping near the Big Island, as had been requested by NMSP and DLNR/DAR earlier in the year.
6. Two Office of Coast Survey physical scientists, Megan Palmer and Paul Turner participated in HI-06-05 to verify calibrations of the multibeam survey system aboard the *Hi'ialakai* and the R/V *AHI*. Calibration surveys were run as part of the cruise and a comprehensive report of the calibration results was prepared during the cruise. A final version of this report will be published at a later date.
7. OCS personnel provided training to familiarize CRED and NMSP mapping personnel in the use of CARIS processing software and “navigation surface” techniques for multibeam data processing. OCS and USFWS personnel were also cross-trained in methods used for surveying and data processing aboard the R/V *AHI* and the *Hi'ialakai*. See Appendix B.

8. During the cruise, CRED and NMSP personnel analyzed synthesized bathymetric data from this and previous cruises to produce maps of humpback whale distribution with respect to various bathymetric parameters such as depth, slope, complexity, and bathymetric position index (seafloor geomorphology). A presentation of these results was given by Susan Vogt and Emily Lundblad at the Sanctuaries Advisory Council meeting on May 18 as described in Appendix C.

**SCIENTIFIC
PERSONNEL:**

Joyce Miller, Co-Chief Scientist, Mapping Team, Joint Institute for Marine and Atmospheric Research (JIMAR), University of Hawaii (UH), Coral Reef Ecosystems Division (CRED)
Susan Vogt, Co-Chief Scientist, National Oceanic and Atmospheric Administration (NOAA), National Marine Sanctuaries Program
Scott Ferguson, System Test Coordinator, Pacific Islands Fisheries Science Center (PIFSC), National Marine Fisheries Service (NMFS), CRED
John Rooney, UH-JIMAR, PIFSC-CRED
Emily Lundblad, UH-JIMAR, PIFSC-CRED
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Jonathan Weiss, UH-JIMAR, PIFSC-CRED
Kyle Hogrefe, UH-JIMAR, PIFSC-CRED
Frances Lichowski, UH-JIMAR, PIFSC-CRED
Jamie Smith, UH-JIMAR, Hawaii Mapping Research Group
Ron Salz, U.S. Fish and Wildlife Service
Megan Palmer, NOAA Office of Coast Survey
Paul Turner, NOAA Office of Coast Survey

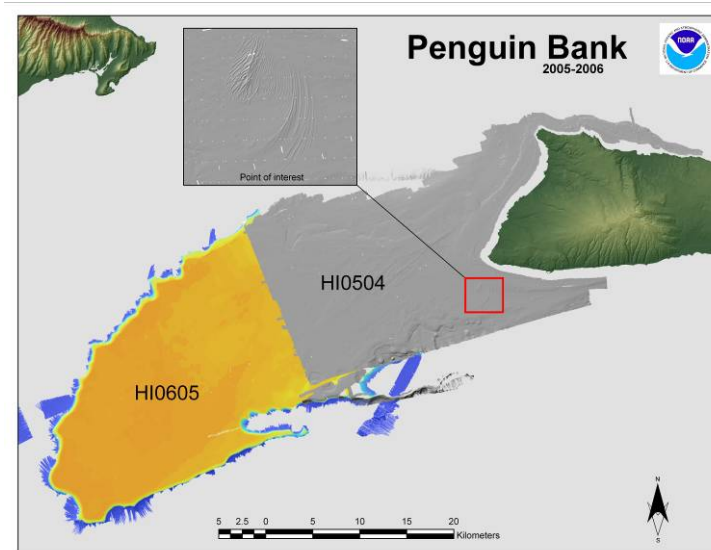
(/s/Joyce Miller)

(/s/Susan Vogt)

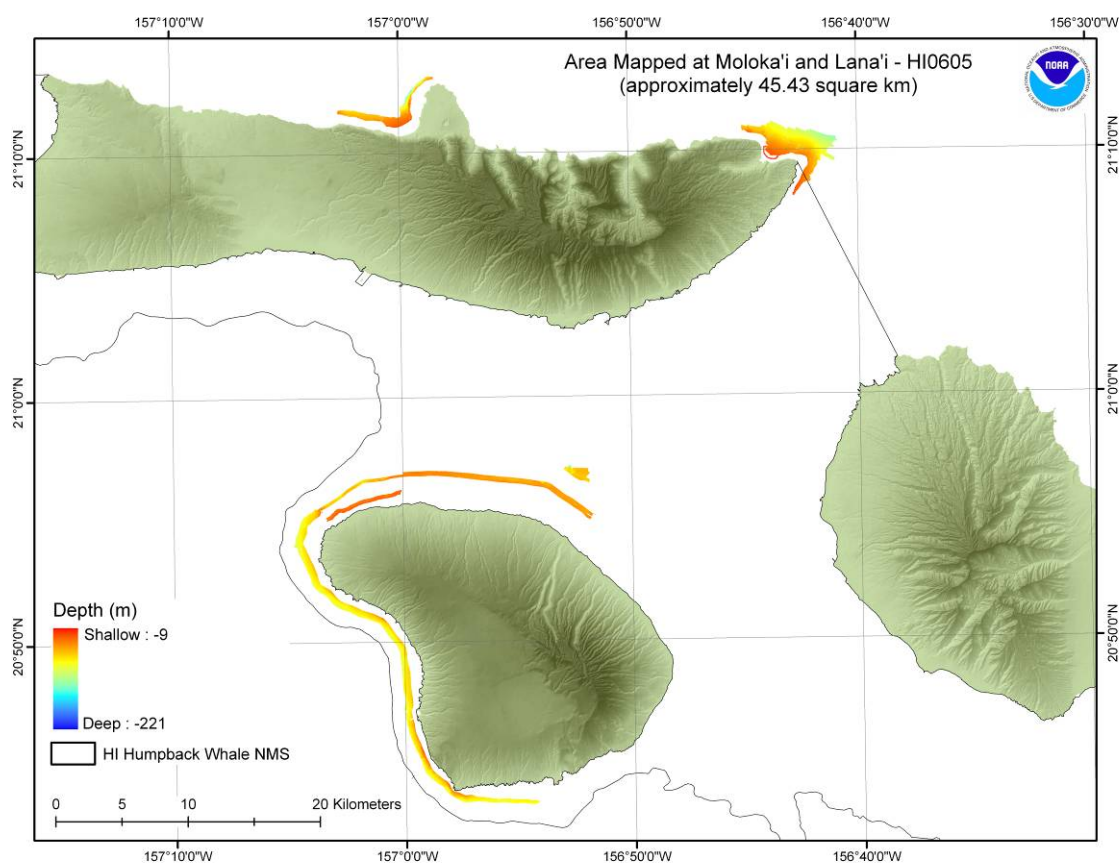
Submitted by: _____
Joyce Miller
Co-Chief Scientist

Susan Vogt
Co-Chief Scientist

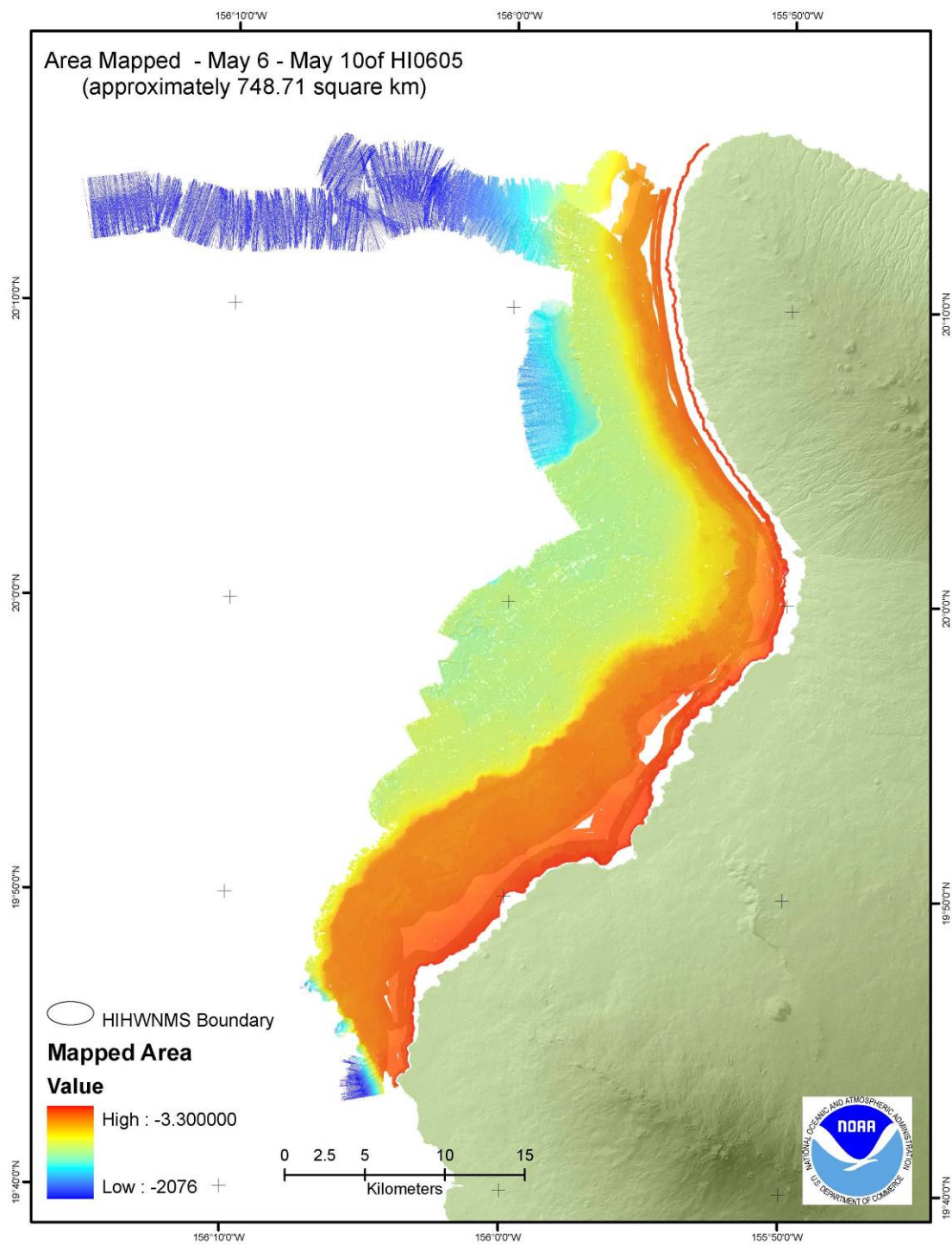
(/s/David Kennedy)
Approved by: _____
David Kennedy
CRCP Program Manager



HI-06-05 Multibeam Coverage on Penguin Bank.



HI-06-05 Multibeam Coverage around N. Molokai and Lanai.



HI-06-05 Multibeam Coverage on N.W. Coast of Big Island of Hawaii.

Appendix A

HI-06-05 Multibeam Mapping Results

Multibeam mapping priority areas on cruise HI-06-05 were determined after consultation with a number of NOAA groups and other agencies which included the NOAA Coral Reef Conservation Program (CRCP), the Coral Reef Ecosystem Division (CRED) of the Pacific Islands Fisheries Science Center (PIFSC), and the National Marine Sanctuaries Program (NMSP), as well as the Hawaii Department of Land and Natural Resources/Division of Aquatic Resources (DLNR/DAR), the University of Hawaii, and the U.S. Fish and Wildlife Service (USFWS). It was determined that the completion of mapping on Penguin Bank was of highest priority for HI-06-05. Other areas where existing coverage was incomplete near Molokai and Lanai were also targeted for possible survey work and 2 days were spent working on these areas. Because of unexpectedly good conditions, Penguin Bank was completed in 9 days and sufficient time (6 days) was available to allow transit to the Big Island of Hawaii and survey on the northwest coast. A total of 1378.82 km² in the Main Hawaiian Islands was surveyed during HI-06-05.

Penguin Bank

Penguin Bank is a large shallow (waters are less than 60 m deep) area southwest of Molokai and south of Oahu that is included in the Humpback Whale Sanctuary because a large number of humpback whales congregate there. Penguin Bank is also important to fisheries interests because it is one of the most popular fishing grounds in the Main Hawaiian Islands. Survey was begun on Penguin Bank in 2005 during cruise HI-05-04 and approximately one-half of the bank was mapped (592 km²). One day of additional mapping was done at the end of cruise HI-06-04 during transit from Palmyra Island to Oahu. Nine days of mapping were done during HI-06-05; 584.68 km² of survey coverage was completed on Penguin Bank in 2006 (Figure A-1). The R/V *AHI* was deployed for 2 days on Penguin Bank during HI-06-05.

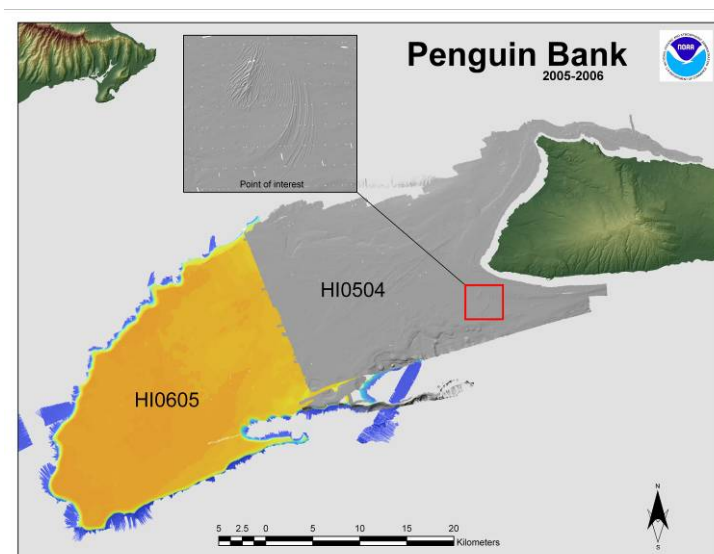


Figure A-1: 2005-2006 Multibeam Coverage on Penguin Bank.

While the top of Penguin Bank is relatively flat with depths generally ranging between 40 and 60 m, there are numerous interesting features that have been revealed through the high resolution bathymetry (Figure A-2), which was fully processed during HI-06-05. Sand waves and dunes are seen in the eastern portion of the survey (inset, Figure A-1), linear ridges extend in from the northeast to southwest across the bank, complex bathymetric features occur at the edges of the bank, and the southwest edge of the bank is clearly shallower than the central and northeast section of the bank.

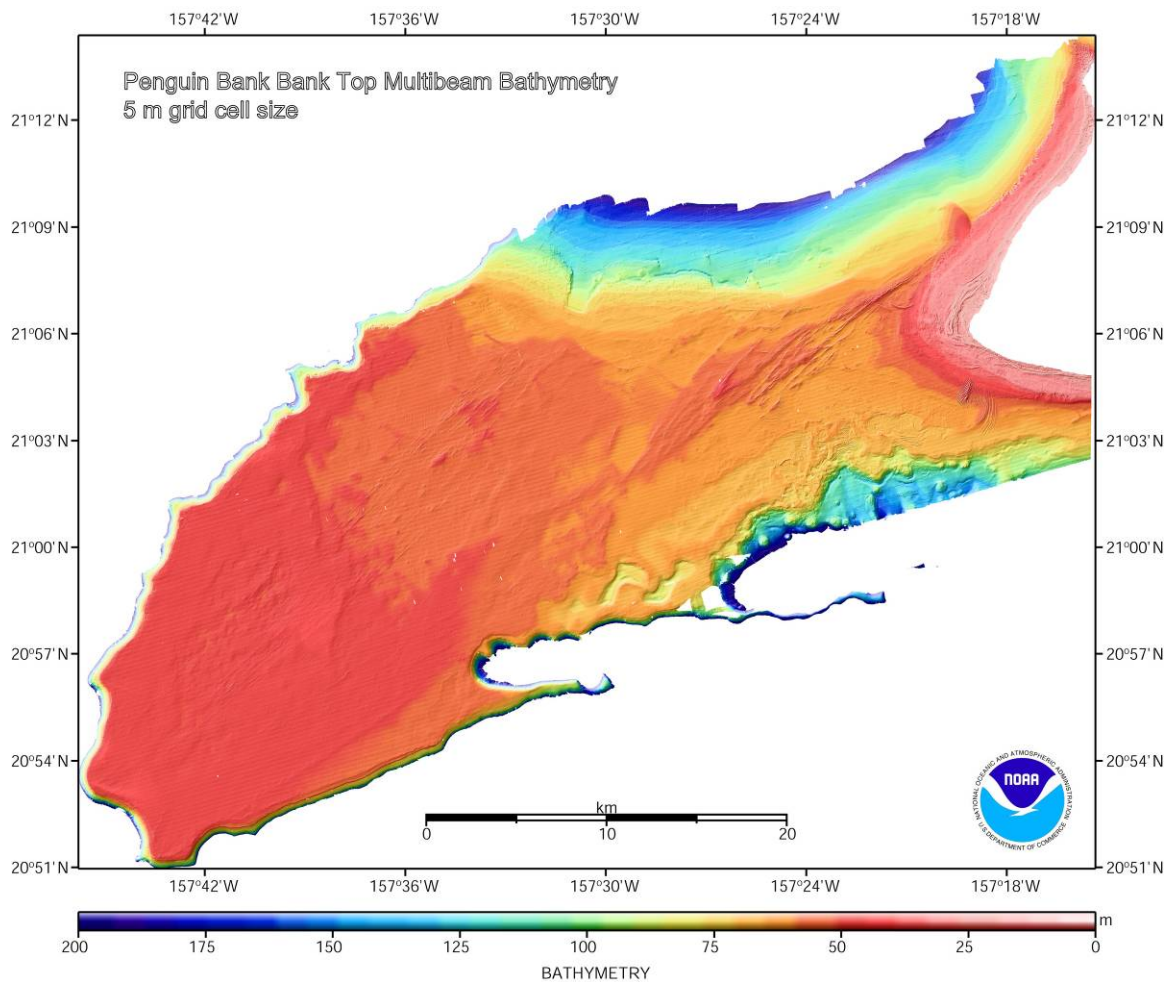


Figure A-2. Bathymetric data from Penguin Bank.

During HI-06-05, preliminary processing of backscatter data (Figure A-3) from HI-05-04 was begun. This backscatter data shows additional complexity that was not evident in just the bathymetry. Processing and interpretation of the data is ongoing.

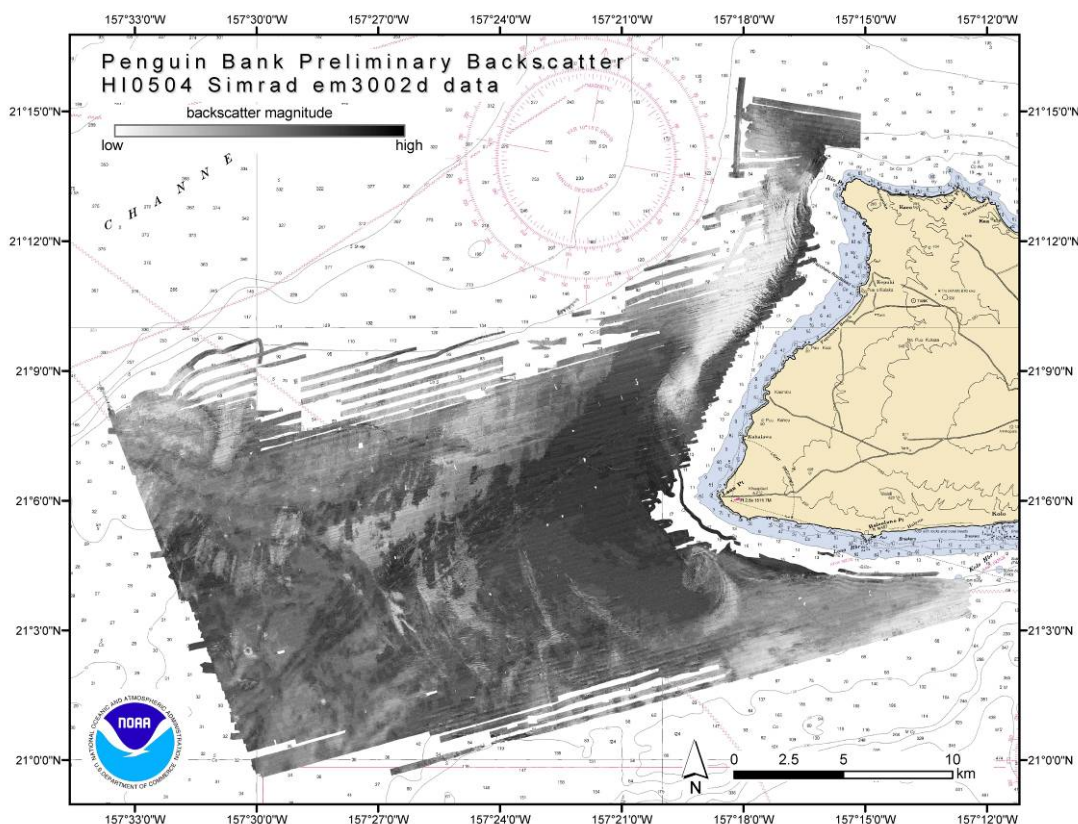


Figure A-3: HI-05-04 EM3002 Multibeam Backscatter Data that was processed during HI-06-05.

Molokai and Lanai

CRED, NMSP, and the University of Hawaii are collaborating to complete bathymetric mapping of the Main Hawaiian Islands and synthesis of these data. The resulting data can be used for a wide variety of purposes, such as analysis of habitat for humpback whales (Appendix B). As part of this synthesis effort, 2 days of *Hi'ialakai* and *AHI* mapping were done to fill gaps in previous multibeam maps on the north coast of Molokai at Halawa Bay and near Kalaupapa Peninsula and around Lanai (Figure A-4).

Big Island of Hawaii

On the northwest coast of the Big Island of Hawaii, there was a large gap in multibeam coverage in the Humpback Whale Sanctuary. Water depths up to 183 m (100 fm) are included in the NMSP Humpback Whale Sanctuary, and mapping in water depths from 50 to 500 m is needed by the PIFSC and Hawaii DLNR/DAR for definition of Essential Fish Habitat (EFH) that is important for management of Hawaii fisheries. A total of 748.71 km² of survey were completed in 5 days of work by the *Hi'ialakai* and *AHI*. (Figure A-5.)

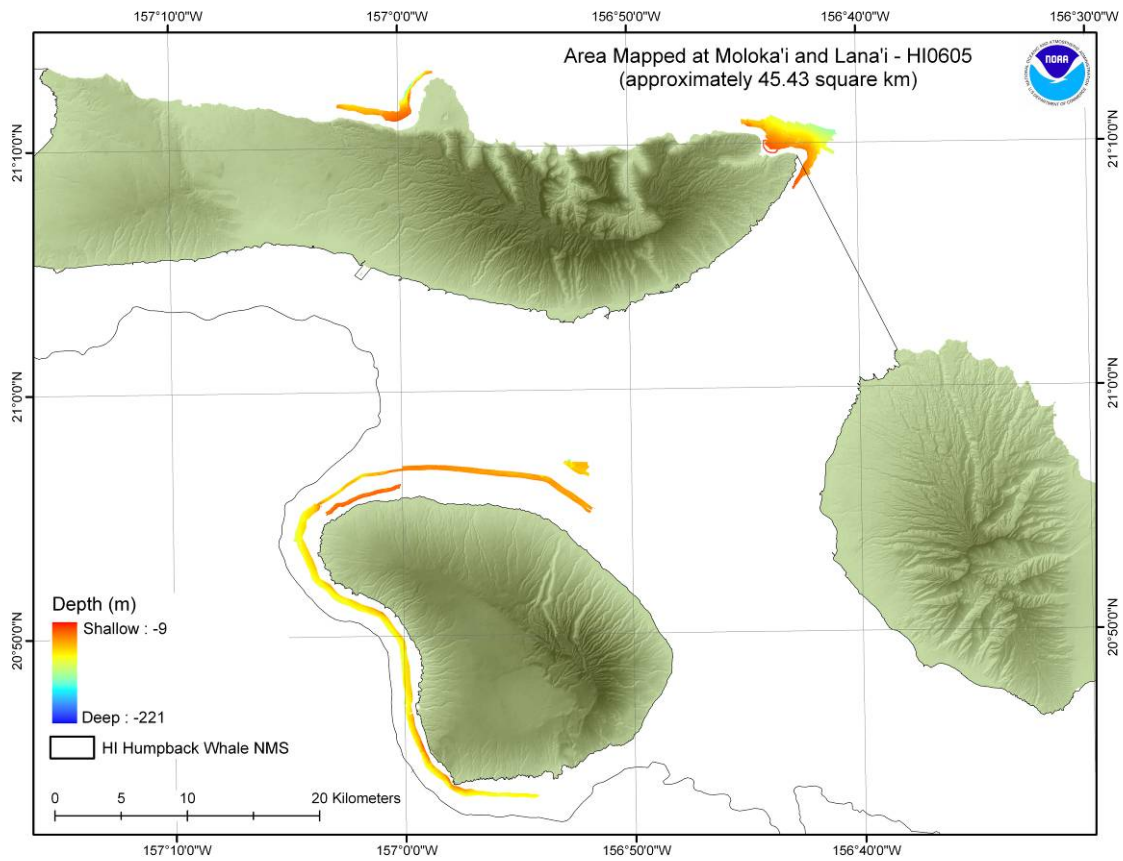


Figure A-4: HI-06-05 Survey Coverage around N. Molokai and Lanai.

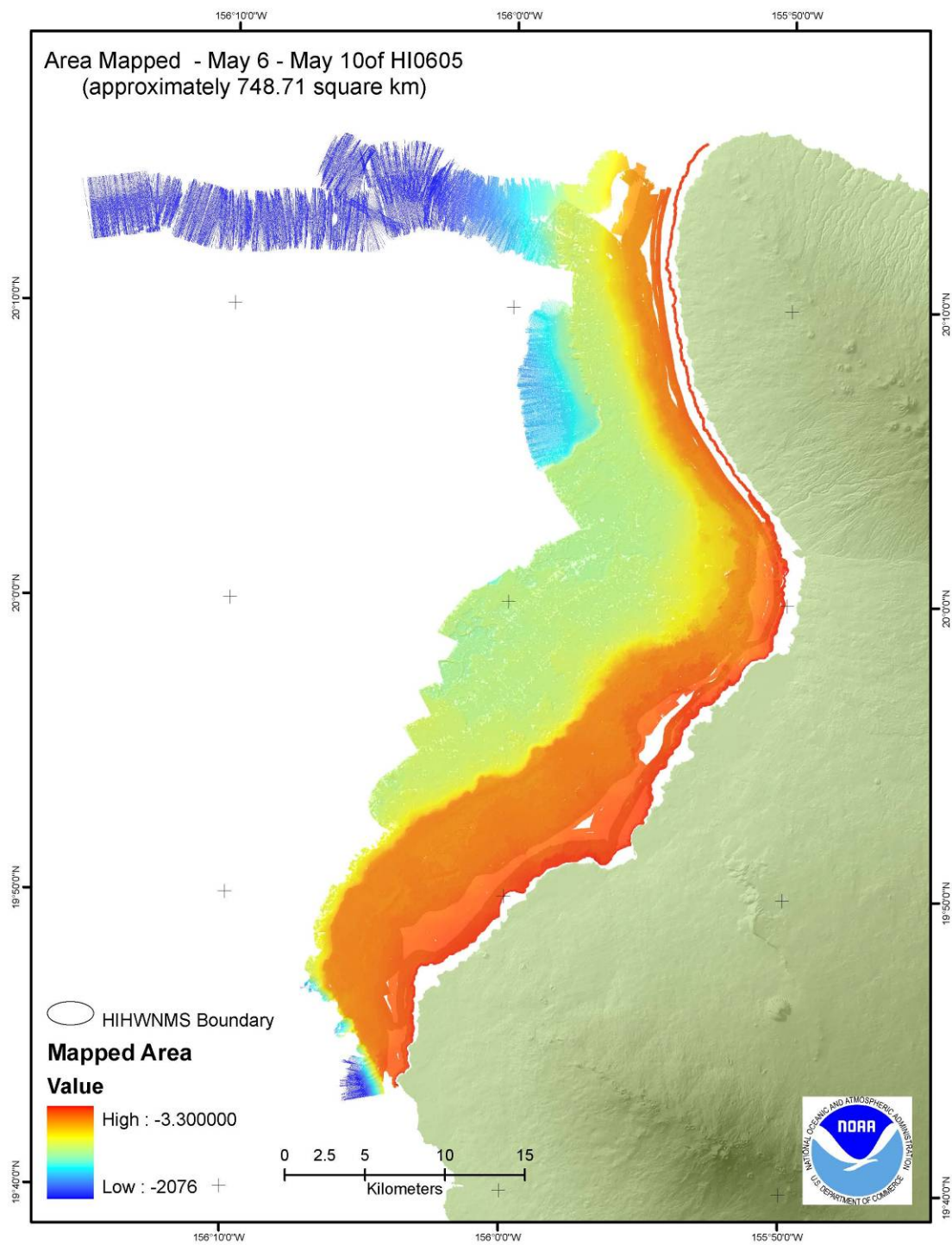


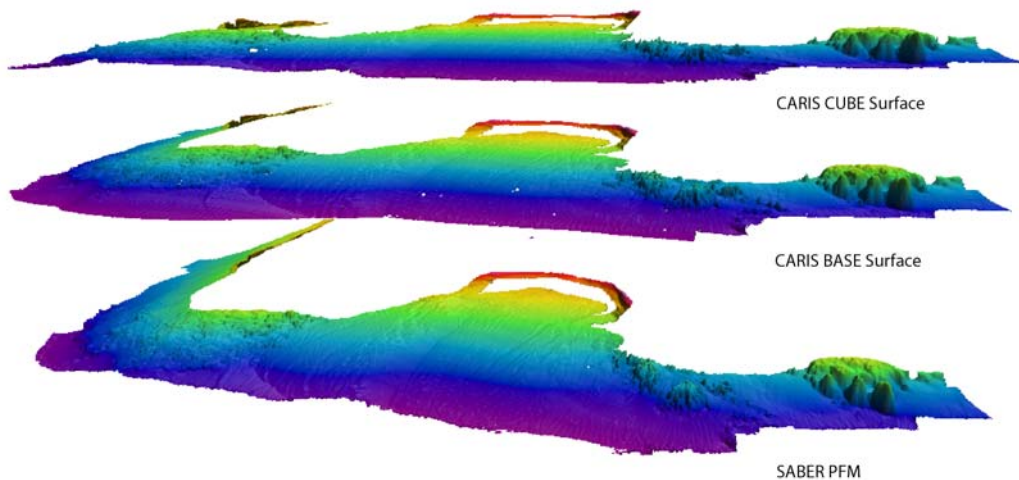
Figure A-5: Multibeam Coverage on NW coast of Big Island of Hawaii.

Appendix B

Comparative Analysis of Editing with SABER, CARIS and CUBE in CARIS

During the course of HI0605, representatives from NOAA's Office of Coast Survey (OCS) and from the Pacific Islands Benthic Habitat Mapping Center (PIBHMC) collaborated on a comparison of post-processing software. Data collected off of east Moloka'i using the RESON 8101 multibeam sonar system on the R/V Acoustic Habitat Investigator (AHI) was edited using SAIC's SABER and with CARIS. The post-processed data was exported as XYZ files. Three final data sets were used in the comparative analysis: a CARIS base surface, a CARIS CUBE surface and a SABER PFM. Each one was imported to Fledermaus for 3D visualization (Figure B-1). The bathymetric grids look very similar in the visualization. Reds to purples represent shallow to deeper depths respectively.

BATHYMETRIC GRIDS



6X Verticle Exaggeration

All data where collected using a RESON 8101 Multibeam Sonar System

Figure B-1: Bathymetric grids were post-processed in SABER and CARIS

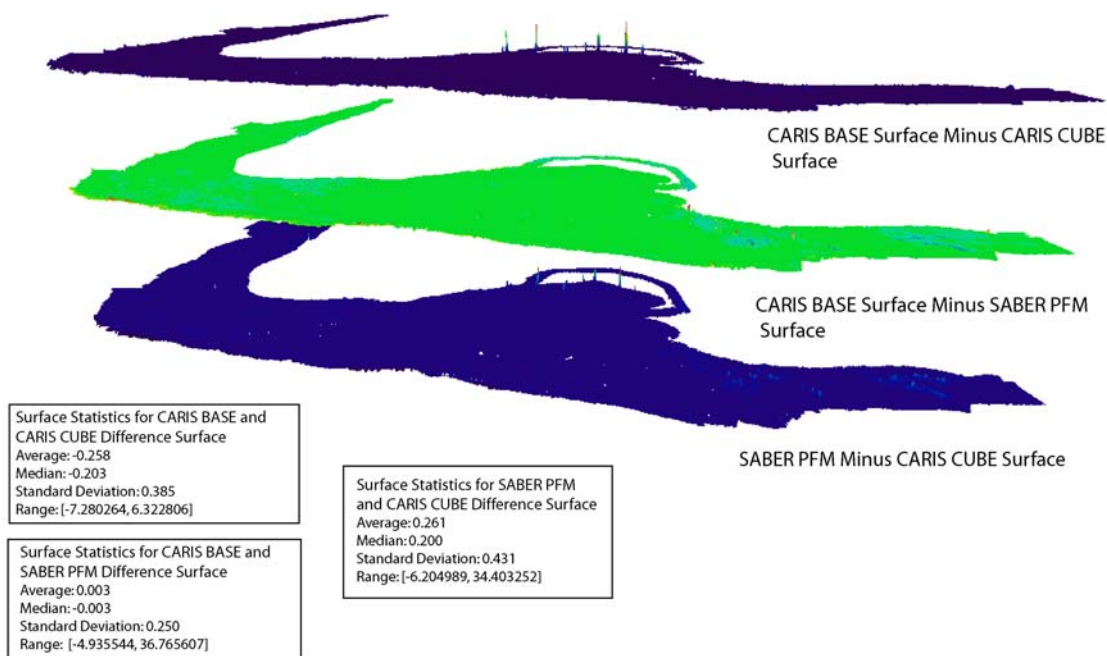
To get a more explicit look at the differences between the grids, a surface difference was run in Fledermaus to create three separate surface difference grids. They calculate statistics for the following three differences: the CARIS base surface minus the CARIS CUBE surface, the CARIS base surface minus the SABER PFM surface, and the SABER PFM surface minus the CARIS CUBE surface (Figure B-2). Each difference surface is summarized with surface statistics (Figures B-3a-3c).

By simply using the average from each one, we can conclude that the CARIS base surface and the CARIS CUBE surface have very similar results (0.003). The purple on the difference surfaces indicates zero difference. From the histogram and the 3D analysis for this comparison, we see that most of that difference comes from a few outliers on the edge of a swath in the shallow part of the grid. These outliers were not rejected in the CARIS CUBE post-processing, and they clearly contribute to the difference surface.

The SABER PFM surface compared to the CARIS base surface and the CARIS CUBE surface results in average differences of -0.258 and 0.261, respectively. A clear difference between SABER and CARIS surfaces is seen across the entire surface; this is indicated by the green and blue colors diverting away from the purple (= zero difference). Though the difference is quite small, there is rarely a place where there is NOT a difference. This difference is thought to be caused by using a SABER minimum filtered surface for this analysis. Future work will be to export a SABER average surface and compare it with the CUBE surface.

A consideration that should be noted here is that the files were edited in SABER by a different person than the files edited in CARIS. This comparative analysis will be repeated in the future with another dataset, using one editor, to get an idea of how much observer dependence played a role in this analysis. Perhaps, we should also consider adding a surface to the comparison by using CUBE in Fledermaus area based editing tools.

Difference Surfaces



All data were collected with a RESON 8101 Multibeam Sonar System

Figure B-2: Difference Surfaces derived in Fledermaus

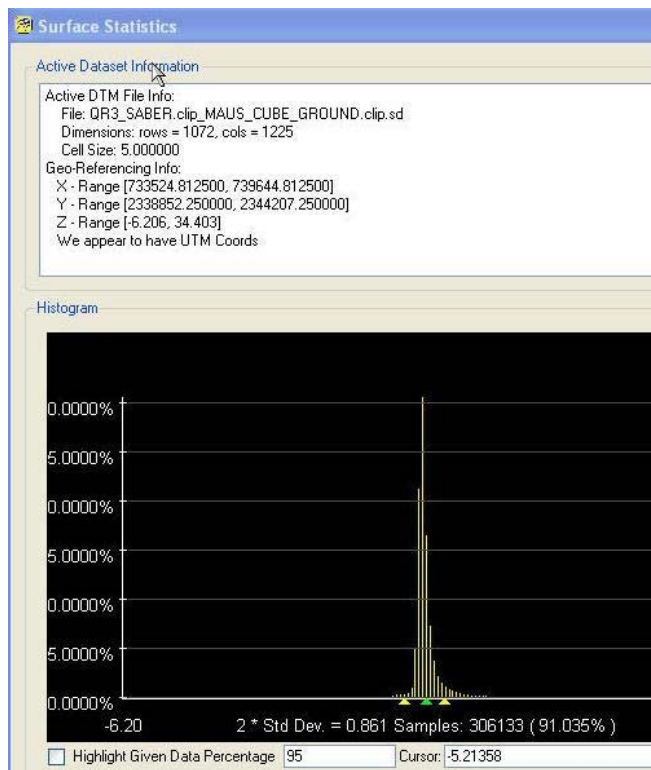


Figure B-3a: Surface statistics for SABER PFM surface minus CARIS CUBE surface

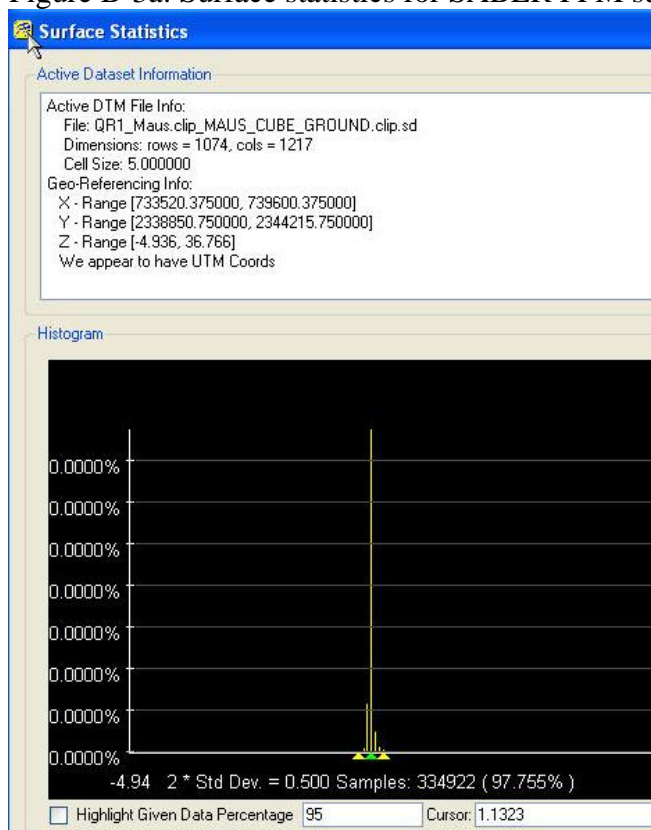


Figure B-3b: Surface statistics for CARIS base surface minus CARIS CUBE surface

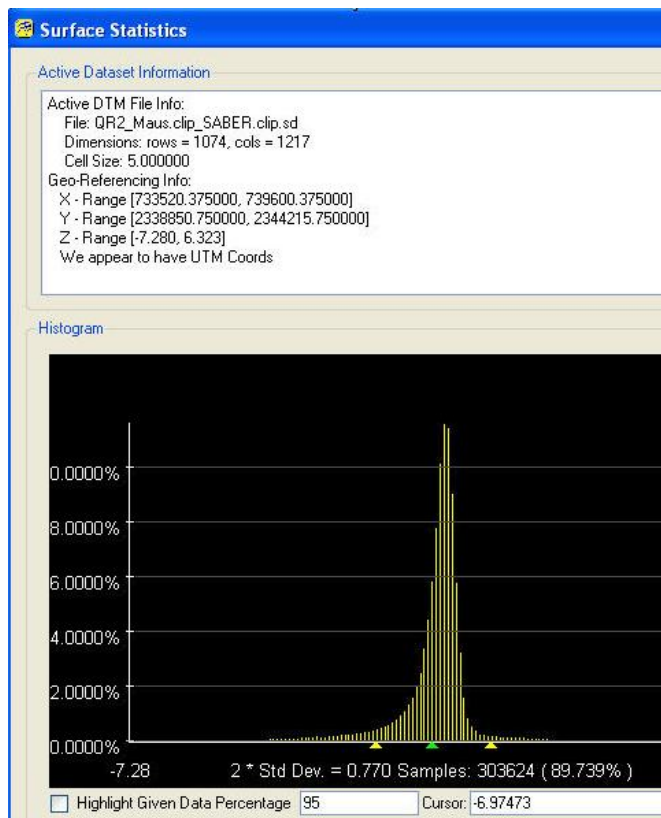


Figure B-3c: Surface statistics for CARIS base surface minus SABER PFM surface

Appendix C

Seafloor Characterization at locations of Humpback Whale Sightings

The 1274 square kilometers of data collected during the HI0605 cruise aboard the NOAA Ship *Hi'ialakai* will be added to a bathymetric data synthesis. The synthesis, begun by the University of Hawaii's School of Ocean and Earth Sciences (SOEST) and the Hawaii Underwater Research Lab (HURL), incorporates data from a wide variety of mapping groups and includes academic, state, and federal data. The bathymetry collected during HI0605 will be added to the synthesis in order to make preliminary assessments of seafloor characteristics across the state. In a collaborative effort, between the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS) and the Pacific Islands Benthic Mapping Center (PIBHC), mapping staff on HI-06-05 began looking at possible correlations between seafloor surface structures and reported whale sightings, based on data collected prior to HI-06-05. First, the merged bathymetry data was used to develop a regional spatial analysis. The spatial analysis includes the derivation of slope, rugosity, and bathymetric position index (BPI) zones in ArcMap's Spatial Analyst extension and an ArcMap extension, the Benthic Terrain Modeler. Slope is a measure of steepness, rugosity is a surface ratio that translates degrees of roughness, and BPI zones categorize benthic terrain with a combination of depth and slope.

The resulting values from each of the spatial grids were combined with whale sighting data from the HIHWNMS to determine if there were any apparent patterns/relationships between the sightings and grid values of depth, slope, rugosity and BPI. Preliminary results indicate that the majority of humpback whale sightings occurred over very smooth, flat areas (< 5% slope) shallower than 500 fathoms, indicating that there is, indeed, a correlation between humpback whale sightings and seafloor characteristics.

The analysis will be continued post-cruise, and will be presented to HIHWNMS management and researchers for further refinement and interpretation. In addition, the spatial analysis will serve as the basis for Sanctuary characterizations efforts incorporated into the Sanctuaries' upcoming Management Plan Review process.

Results of preliminary analysis of seafloor characteristics and whale sighting locations:

Slope (deg)	# Sightings	% Sightings
Flat (0-5)	1383	56.33401222
Moderate (5-12)	306	12.46435845
Steep (12-19)	121	4.928716904
Very Steep (>19)	103	4.195519348
Unknown (No Data)	542	22.07739308
Total	2455	100

Rugosity	# Sightings	% Sightings
Very Smooth	1637	66.6802444
Smooth	131	5.33604888
Moderate	43	1.751527495
Rough	67	2.729124236
Unknown (No Data)	577	23.50305499
Total	2455	100

BPI Zone	# Sightings	% Sightings
Crest	354	14.41955193
Depression	68	2.769857434
Flat	1153	46.96537678
Slope	338	13.76782077
Unknown (No Data)	542	22.07739308
Total	2455	100

Depth (meters)	# Sightings	% Sightings
< -91.5	840	34.21588595
-91.5 - -183	340	13.84928717
-183 - -914	604	24.60285132
-914 - -1830	63	2.566191446
>-1830	66	2.688391039
Unknown	542	22.07739308
Total	2455	100

It should be noted that much of the seafloor in the “Unknown” category was mapped during HI-06-05. These data will be added to the synthesis, and updated statistics will be produced.

The final results from this spatial analysis will give managers an overview of the seafloor characteristics that lay under ‘hot spots’ of humpback whale sightings. Managers will be able to see how those characteristics that correlate with whale sightings are distributed in relationship to current Sanctuary boundaries. Such results may indicate how well current jurisdictions match actual whale distributions and could offer insight into if and how managers should consider implementing changes to jurisdictional boundaries or regulations to make the Sanctuary more effective.

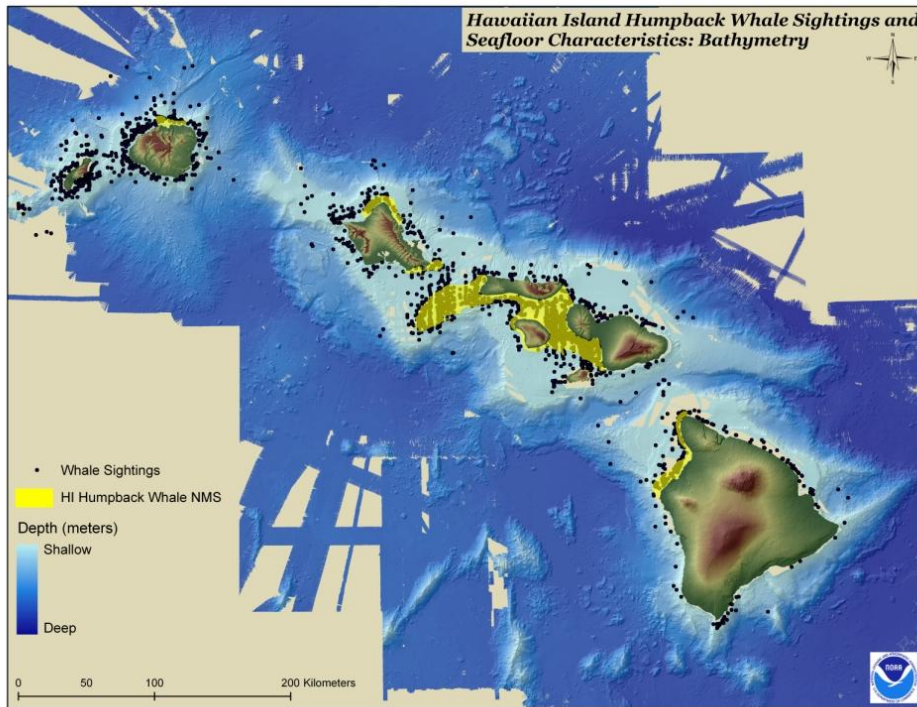


Figure C-1. Bathymetry and Humpback Whale Sightings

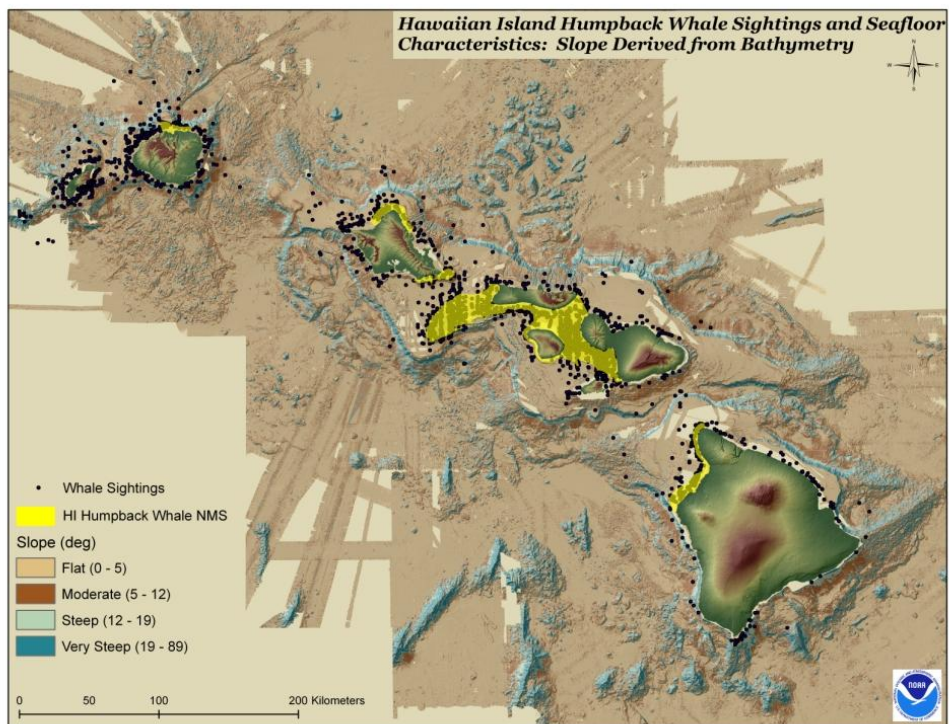


Figure C-2. Slope and Humpback Whale Sightings

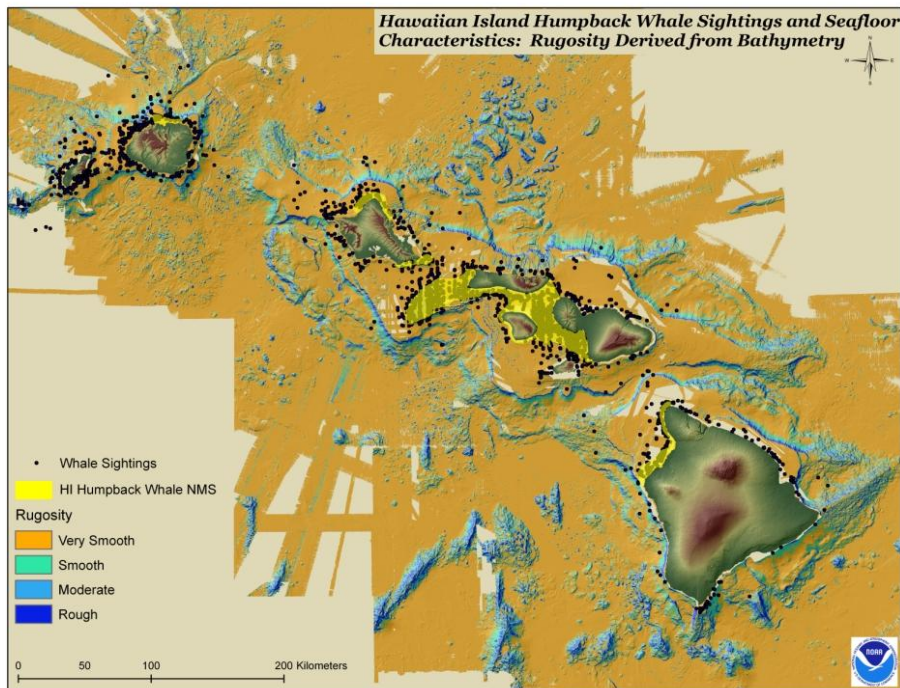


Figure C-3. Rugosity and Humpback Whale Sightings

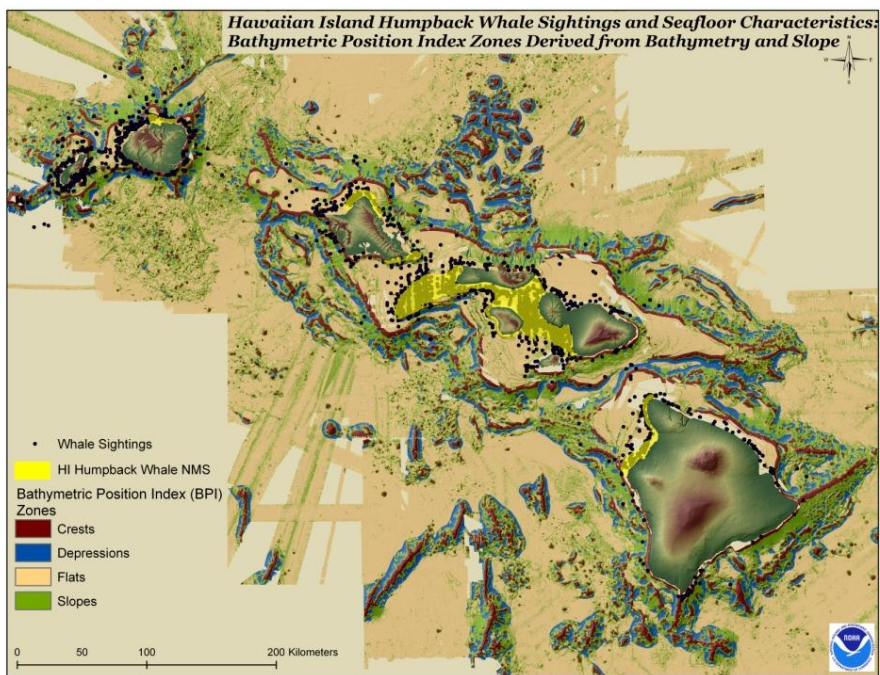


Figure C-4: Bathymetric Position Index and Humpback Whale Sightings